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A PERIODICAL SURVEY OF NEW DEVELOPMENTS IN THE CONTROL OF PESTS, DISEASES AND WEEDS

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EDITORIAL

CROP protection problems in Belgium, the U.S.A. and India are discussed by experienced workers in their respective spheres of activity in contributions to this number of the *Overseas Review*.

An interesting paper on the care and upkeep of pastures in Belgium, with a section on suppression of weeds by hormone weedkillers, stresses the vital importance of regarding grass as a crop, which therefore needs as much cultural treatment as any arable crop.

A reprint of a speech by Mr. Linden E. Harris of Chipman Chemical Company, U.S.A., published in this journal by kind permission of Chipman Chemical Company and the author, discusses authoritatively the important question of weed and brush destruction on railroads in that country. This contribution forms a valuable addition to the series of articles in the *Overseas Review* on weed treatment in different parts of the world.

A contribution from India deals with the treatment of blister blight of tea in that country by the use of copper fungicides. The author, who has had wide experience of tea cultivation and diseases of this crop, describes the recent developments in this important branch of crop protection.

GRASSLAND MUST BE IMPROVED

by P. F. AERTS, Ingenieur Agronome, A.I. Gx.
Technical Department SELCHIM—Solvay Plant Protection

PASTURE improvement is of equal importance to that of progress in general crop production. This paper presents an introductory discussion of the agricultural practices necessary for the general and lasting improvement of permanent pastures based on experience gained in Belgium.

A pasture is a piece of land covered all the year round with a type of vegetation which is capable of feeding a certain number of livestock or which will yield one or two good crops of hay or grass for silage as feed for the winter.

In return, several hundred kilogrammes of fertilizers and sometimes several tons of lime or barrels of liquid manure are occasionally spread on the pasture.

This was the grassland policy of our ancestors, and it is only too true that it is still that of many countries.

The treatment of arable land, on the other hand, usually involves the cultivation of the soil every year according to the latest techniques, a carefully tested fertilizer programme and sowing selected and dressed seed. In other words, we give our arable crops every possible care with one aim : YIELD.

However, irrespective of whether the return from pastures is expressed in terms of cattle, meat or milk yield, the farmer aims to get a satisfactory profit from each of these. The present paper may, therefore, be of special interest to the " grazier." To achieve this aim, farmers and graziers wishing to harvest or graze a larger quantity of good quality grass—which will enable them to feed a larger number of livestock per unit area—will be forced to devote to their grassland the same attention as they would to arable crops, in other words, treat grass as a crop.

The Present Condition of Pastures and why they should be Improved.

There is too great a tendency, as already stressed, to deprive pastures of the care and attention they deserve, often with the excuse that there is no time or money available for them, with the result that the requirements of our population in meat, butter and milk are far from being covered.

It is therefore necessary—one might even say compulsory—to revise our grassland policy completely so as to intensify and rationalize the production of our pastures.

By intensive farming at relatively low cost the grazier should aim at the following targets :

(1) to increase the concentration of live weight, that is to say, the number of livestock per acre ;

(2) to cut down the stabling period by increasing the grazing time ;

(3) to conserve by ensilage, or by drying, the excess of grass which is not consumed by the livestock during the year ;

(4) to reduce proportionally purchases of extra food ;

(5) to increase the number of fatstock—and thus *increase the profit-earning capacity of the farm in general and obtain larger returns from it.*

Before dealing with the various difficulties to be overcome it is necessary to determine their principal causes. Among these we have :

(*a*) Excessive soil moisture, which adversely influences the flora owing to the consequent acidity of the soil and the growth of weeds peculiar to wet and acid soils. This condition also encourages the growth of parasites dangerous to livestock, such as thread-worms (causing husk), hepatic-worms (which attack the animal's liver), etc., against which there has been found up to the present no direct remedy except draining.

(*b*) Lack of air in the soil produced by excess water and consolidation of the soil, which automatically expels the air. This results in the disappearance of the beneficial grasses and clover, which are replaced by coarse and non-productive grasses.

(*c*) The coarsening of certain grasses of mediocre quality and the presence of weeds (thistles, sorrel, rushes, etc.) resulting in patches of vegetation which the stock refuse to graze. The productive area of the pastures is thereby reduced.

(*d*) The influence of unbalanced dressing and lack of lime on the botanical composition of the grazed or cut pastures and thus on the palatability of the grass and the richness of the latter in digestible protein and mineral salts, which are essential factors for the productivity and health of the grazing stock.

It is therefore essential to restore to the pastures the elements which are being continuously removed by mowing and grazing, such as phosphoric acid, potassium and especially nitrogen and humus, and to add regularly lime, all of which are essential for the growth of beneficial grasses.

All these causes are responsible for the lack of profit-earning capacity of pastures, but the consequences may be averted by some of the means available to any good farmer.

Of the agricultural methods likely to improve pastures we shall give special attention to the following, in view of their primary interest: the botanical composition of the pastures before improvement—a basic study, which will help to guide the farmer in any other necessary work, the deep aeration and tilling of the top-soil of pastures, which are capable of producing extremely beneficial results, and rotation and management.

Botanical Composition of Pasture.

A botanical analysis is the basis of any research for improving grassland.

In fact, the value of a pasture depends entirely on the agricultural value of the species of grasses and clover of which it is composed, and not—as there was a tendency to believe formerly—on the chemical composition or on the yield in weight of the grass-crop.

For example, velvet-grass (*Holcus lanatus*), a very productive species, rich in minerals, crude protein and starch, is of very inferior quality from the agricultural point of view because of its " downy " nature, its faculty for forming patches, and the rapidity with which it causes hay to go mouldy.

Consequently, when a pasture is being laid down or improved the farmer should not use the seed from the bottom of the hayloft—which he would not in any case do when sowing wheat—but he should get the advice of technical experts. There are official research stations from which advice on suitable seeds mixture for particular conditions can readily be obtained.

Deep Aeration and Tillage of Top-Soil of Pastures.

Unless, as in an extreme and desperate case, one is compelled to plough up the old pasture, it would be unreasonable to deny that great benefits result from the tilling of soil which has consolidated after years of trampling by livestock, the effects of bad weather and passage of farm implements.

With *deep* tillage—and we stress the importance of this word—air penetrates freely to 10—15 cms., that is to say, below the root zone. This work should be carried out with a grassland " regenerator," the steel blades of which should penetrate at least 10—11 cms. deep, requiring the application of fairly great tractive force.

Too many manufacturers of agricultural implements, and farmers, however, still confuse the use of the " regenerator " with " spike harrowing." The latter is intended more especially for tilling the top-soil, that is to say not more than 5 cms. deep. Though this implement, which does not penetrate deeply into the ground, is of certain value for the general upkeep of pastures, its use is out of the question for the important work of regeneration.

From the mechanical angle the *real* regenerator can be recognised by the special shape of its blades. These have to penetrate the

ground like the coulter of a plough and must be very sharp along the whole length of the blade and have a definite triangular cross section. The rear face of the blade must be flat and 2 cms. wide at least. The angle of the machine must be regulated so that the knives of the first line penetrate the earth to a depth of 8—9 cms. and the rear line 10—11 cms.

The author has seen several regeneration operations effected with a machine with 6 or 7 knives, 25 cms. apart, working to the above-mentioned depths. Under these conditions a 22—24 H.P. tractor had to be driven at full power so as not to skid, even on fairly dry grassland. The tractive force required must not, therefore, be under-estimated. Moreover, if a tractor with that power was able to pull without difficulty a regenerator of more than 1.5 m. wide fitted with 7 sharp knives, the logical conclusion would have been that the operation had not been satisfactory.

From the agricultural angle, deep aeration of the grassland soil produces many very beneficial changes at the root level of the grass and in the plants themselves. In the soil it results in the formation of humus owing to the beneficial action of aerobic bacteria, the formation of a layer of friable loose ground, a reserve and free movement of soil water, improved activity of soil bacteria, improvement of soil structure, rapid penetration of fertilizing elements, and easier warming of the soil. In the plant there is improved growth owing to more complete assimilation of the soil nutrients, a better developed root system capable of penetrating deeper into the soil, and improved chlorophyll action.

The results obtained by the author from the thorough regeneration of some pastures are here presented. The figures show the average yields of grass cut in regenerated and manured pastures (A), in pastures similarly manured but not regenerated (B) and pastures which were neither regenerated nor manured (C).

Pastures A : 35.694 kgs. per hectare

Pastures B : 17.205 kgs. per hectare

Pastures C : 14.757 kgs. per hectare.

These figures require no comments.

Deep regeneration also results in some further important advantages, such as the possibility of partially resowing the grasses, of incorporating with the soil a well-balanced dressing or applying insecticides for controlling underground larvae (wireworms, white grubs, etc.), the hidden damage from which is the basic cause of a bad pasture more often than one realises.

When regeneration is carried out in grazed orchards it very noticeably promotes the growth, health and productivity of the fruit trees. Clumps of mediocre grasses and various weeds (*Agrostis*, rough meadow grass, thistles, dandelions, etc.) are destroyed, the ground is levelled, ungrazed patches are removed and the regenerated pastures remain productive the whole year round.

Usually, regeneration is carried out in one direction in pastures which are poor in humus content and in both directions in those rich in humus. The operation is carried out before growth has started in one direction in October—November and in the other direction in the spring, as soon as the ground can be tilled. After the application of fertilizers and insecticides and re-sowing, the pasture is rolled so that the soil may be compacted and resume close contact with the new roots produced as a result of the thorough aeration of the cultivated layer.

Regeneration is, however, not suitable in all cases. For instance, in pastures composed of very mediocre grasses, where the only remedy would be ploughing up, the effect of regeneration would be to encourage germination of seeds of numerous weeds or of mediocre grasses such as bromus, holcus, vernal grass, etc. Regeneration is also undesirable in heavy and very wet soils, where the soil would be hardened in dry weather to such an extent that the furrows made by the regenerator would remain open, and in very light and dry soils, where the regenerator would pull up all the plants, leaving them no chance of their taking root again. In leys (temporary pastures) where the soil is insufficiently consolidated, the regenerators should be replaced by less drastic machines, such as chain-harrows.

In all other cases, which constitute the majority, deep regeneration is a very important and highly recommended operation.

Rotation of Pastures.

Rational grazing of pastures, by means of a proper system of rotation similar to that which is practised in large-scale arable farming, provides another big step towards pasture improvement. This necessitates the provision of suitable fencing for this type of intensive farming, drinking troughs within reach of all the fields, without any loss of space, silos for storing the green fodder which the livestock is unable to consume, and the spreading of quick-acting nitrogenous fertilizers after the livestock have grazed each of the fields.

Balanced Fertilizing, Lime and Extra Nitrogen.

The use of ample and balanced dressings must be especially recommended.

As regards *phosphoric acid*, superphosphates should be used in preference to slag in soils with a basic reaction and vice-versa in acid soils. Superphosphates should be applied before the end of March and the slag before the end of January.

As far as *potash* is concerned, it is necessary to apply this before the winter and to remember its very marked influence on the growth of clover.

Organic dressings in the form of farm manure or liquid manure give excellent results and constitute an important source of humus. They have one disadvantage, however, in that they encourage profuse weed growth.

Special attention should be given to the mineral *nitrogenous fertilizers*. In order to produce healthy and rich herbage and to maintain its regular and constant growth it is essential to supply it with successive doses of these quick-acting fertilizers. Depending on the climate and the system of farming, a minimum of four annual applications of a good nitrogenous fertilizer will be essential at the end of April, at the beginning of June and August, and possibly at the beginning of September.

These extra dressings produce grass rich in digestible protein throughout the season and are the principal factors in keeping the pasture productive even during the dry and hot season.

Finally, lime has many great advantages provided that it is applied at the required dosage every 3 years rather than in one large dosage at much longer intervals. The best season for liming is the autumn, and the pH of the soil should be determined before deciding upon the dosage to be applied.

Selective Weedkilling in Pastures.

The grazier should give his full attention to improving the botanical composition of the pastures. It is, therefore, essential to note the plants which should be conserved and those which should be eliminated.

It is the desire of all farmers to see an abundance of good grasses with the right proportion of clovers in their pastures. The latter grow more quickly than grasses, have a very high nutritive value and grow well during the dry season.

By " weed " should be understood " *any plant which is not in its right place in a pasture*," and the following could be added, " *and reduces the productivity of the pasture.*"

Among the plants complying with this short definition are undesirable grasses and broad-leaved weeds.

Attention has frequently been drawn in this paper to the necessity of destroying grasses with a poor nutritive value, as well as to various specific remedies with this end in view.

Since there are no weedkillers sufficiently selective to destroy only these weeds, mechanical methods (harrowing and regeneration) and a well-balanced dressing provide the only solutions to the problem.

For the eradication of large clumps of *Agrostis* with their creeping roots and rough meadow grass, a good harrowing of the pasture at the end of the winter gives beneficial results. The empty spaces caused as a result of this action should be re-sown with the correct grasses and clover.

The best way of checking velvet grass, which grows profusely wherever cow dung is present, is by spreading fresh dung with the harrow and scything the ungrazed patches. Rotational management also favours the maintenance of good digestible grasses.

Apart from plants such as daisies, yarrow and dandelions, which are harmful only when they are in profusion and cover a large area of the pasture, consideration need be given only to those which the livestock systematically refuse to graze (nettles, thistles, broom, corn rattle, etc.) and others which affect lactation and the quality of the butter-fat (wild garlic, buttercups, groundsel) or are liable to poison livestock (*Ranunculus acris*, *Colchicum* etc.).

Selective Weedkillers for Pastures.

The choice of the specific products to be used on pastures for destroying undesirable plants will depend on the type of plants to be eradicated.

In the past, crude fertilizers (kainite, sylvinite, etc), as well as calcium cyanamide, were thought to have a herbicidal effect. From systematic tests carried out it has been proved that, though these materials did in fact scorch the leaves of certain weeds, their action never had any effect on the roots. Therefore, when using these substances, the farmer should consider them only as fertilizers. Corn rattle (*Rhinanthus major*) is, however, an exception when there are not more than two leaves on the plant, and calcium cyanamide is applied at the rate of 400 kgs. per hectare.

Among the more up-to-date products, organic dyes (DNOC and DNBP), sulphamates and sodium chlorate must not be used on grassland in view of their toxicity to livestock.

Owing to the remarkable results which have been obtained with selective hormones such as MCPA, 2,4-D and the fairly recent brush-killer, 2,4,5-T, these have now come into general use.

Compared with the first mentioned weedkillers, selective hormones act slowly but have very lasting effects. Thus one must not expect to see any results from an application of hormones before 3 weeks have elapsed, though their effect can still be seen 2 and even 3 years after treatment.

With selective hormones it is possible to keep down the usual pasture weeds and to destroy among others :—

buttercups	plantains
daisies	nettles
spiraea	broom
brambles	thistles
dandelion	blackthorn
rushes	self-heal

Other more resistant plants, such as :

sorrel	ragwort
polygonum	hawthorn,

are very much weakened by the action of the hormones.

There are a few plants which are not destroyed by these products, or, at any rate, no satisfactory method has yet been found to destroy yarrow, colchicum and ox-eye daisies (*Chrysanthemum leucanthemum*) unless repeated and high dosages are applied.

Specific Action of the Commercial Type of Hormones.

Although most farmers still think—and have done for years—that any of the known hormones can be used for any purpose, it is becoming more and more clear from experience that each of the hormones, MCPA, 2,4-D and 2,4,5-T, has its own specific action.

For example, 2,4-D sodium salt is more effective against *dandelions* and MCPA sodium salt against *buttercups*. Thistles are most effectively destroyed with 2,4-D ester. However, as this product is dangerous for neighbouring crops and clover, it is preferable to use MCPA sodium salt which, when applied before the flower buds have formed, gives excellent results. Soft rushes are completely destroyed by MCPA sodium salt.

Nettles, *spiraea*, *brambles*, *goat-weed*, etc. are particularly sensitive to the new brushwood killer based on 2,4,5-T ester.

As regards *yarrow*, there are great hopes that this may be affected by 2,4-D amine.

Whatever the special activity of the product used and even of the type of plant to be destroyed, special importance should be given to the choice of the *treatment period*, to the *method by which the product is used*, and to the *dosage* of the product.

These three factors are of prime importance and finally determine the success or failure of the treatment.

Blame should, therefore, never be too readily attached to any particular brand of product or to the methods of the spraying expert when it is found that a particular weed fails to disappear for no apparent reason.

As regards the most suitable period for treatment, practice has shown that the dandelion is most sensitive from the end of April to the middle of May and between August and October, the buttercup during the whole period of vegetation, but particularly between May and October, and thistles and sorrel when the flower buds are forming.

In general, hormones must be used when the weeds are in full growth and when they have reached a stage of development at which they can absorb these products through their leaves. Spraying should preferably take place when the plants are actively growing and the temperature is around 15° C. Treatment should not be carried out when there is a north or east wind or when rain is imminent.

Except in districts where there is a real shortage of water, dusting with hormone products is not advised in view of the danger to neighbouring crops.

The method which gives the best results at a relatively low cost is spraying with a minimum of 400 litres of solution (and preferably 600 to 700 litres) per hectare. It stands to reason that a thorough and even distribution of the active product on the plants to be destroyed cannot be guaranteed with smaller quantities of solution.

Precautions should be taken to prevent the herbicides from coming into contact with the foliage of fruit trees, ornamental plants and hedges, particularly when 2,4-D or brushkillers are used. To avoid this, applications should not be made in windy weather.

Conclusion.

A reasonable application of the various methods proposed in this paper will ensure the maintenance and recovery of pastures, with satisfactory repercussions on the profit-earning capacity of livestock in mixed farming.

WEED AND BRUSH CONTROL ON RAILROADS

by LINDEN E. HARRIS
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A reprint of a speech delivered June 22nd, 1953, at Saskatoon, Saskatchewan, Canada, in connection with the Thirty-third Annual Meeting and Convention, Agricultural Institute of Canada.

THERE are two main problems of weed control on railroads, (1) the track or roadbed, (2) the off track area or the remainder of the right of way. The eradication, or at least control of weeds and brush on railroads, is becoming increasingly important to maintenance of way officials. There are many benefits and economies derived by railroads by keeping the roadbed free of weeds and the right of way free of brush.

1. Weed Control Facilitates Maximum Drainage of the Ballast and Roadbed. The ballast is probably the most important; certainly it is one of the most expensive maintenance problems on a railroad. The expense and the time necessary to put down a good rock ballast is considerable. It is essential, therefore, that the life of the ballast be extended to the maximum. Inadequate or poorly drained ballast is a good short cut to the time when the ballast will have to be replaced. Plant roots are an effective natural medium for restricting or reducing water movement. It is a good practice, therefore, to keep the ballast free of plant roots to attain maximum drainage. Heavy growth of vegetation will also increase silt collecting, which fouls the ballast. The top growth of plants accumulate silt; roots of these plants hold the silt or restrict its moving out in the drainage water.

2. Weed Control Increases the Life of Ties. This is true of treated ties as well as untreated ties. A tie that is in poorly drained ballast and surrounded by weed roots will deteriorate faster than one that is in a clean ballast.

3. Weed Control Aids Track Inspection and Decreases the Cost of Tie Replacement. This is particularly true where perennial weeds and grasses occur. The added cost of replacing a tie that is in a grass sod as compared to replacing one in a weed-free track may appear to be small for each single tie, but the cumulative cost on thousands of miles of track would be substantial. Any method or technique that would add only one more tie for each man-day would be a worth-while saving.

4. It is well known that Weed Control is Important to Prevent Locomotive Wheel Slipping. There is no railroad that would allow this to occur on main line tracks. It is true, however, that all railroads have branch lines, passing tracks, industry and yard tracks, some of which are overgrown with vegetation that causes wheel slipping to the extent that operating costs are sharply increased. Even on the main lines of first class railroads, if no weed control of any kind was practised for two or three years, plant growth would be extensive enough to cause locomotive wheel slipping.

5. Weed Control Reduces Fire Hazards. Most herbaceous weeds and grasses if not controlled will create fire hazards sometime during the season. Proper weed control, if done when plants are small, will prevent or at least reduce these fire hazards. Application of weedkillers after plants have developed considerable growth will in itself create a fire hazard because of the large amount of dry vegetation that results from the weedkiller. For this reason it is desirable to apply weedkillers early, consistent with proper timing as related to climatic or growing conditions and amount of rainfall. Where railroads go through forested areas, the reduction of fire hazards is very important. It has been found that many fires start on or near the railroad and spread into forest lands. All railroads are expected to make and maintain fire guards through the National Forests. In the past, fire guards have been made with mechanical equipment such as bulldozers scalping off the vegetation. While these have been helpful, they don't entirely control fires and they have been expensive to maintain. During the past two seasons two different railroads in the United States have made applications of weed chemicals to destroy all grass and brush growth in an area extending from 20 to 25 feet from either end of the ties. On both of these railroads results are proving to be very effective and promise increased fire protection.

6. Weed Control Improves Working Conditions of Train Crews and other Railroad Personnel. While there is no way to measure this value directly in dollars and cents, it is evident that good weed control is important from this standpoint. The value received by a railroad may be by indirect means when weeds and grasses are kept under control around switches, passing tracks and yards. Heavy weed growth is objected to by train crews, not only because it is disagreeable to walk through tall vegetation that is often wet from rain and dew, but most switchmen will complain that weeds are a working hazard that can cause serious accidents from falling in tangled growth of wild blackberries and tall vegetation. One railroad in the States this season received so many complaints from train crews on a certain branch line that they found it necessary to spray this branch line although it was late in the season and after all other chemical weed control on this road had been completed for the year.

7. Weed Control on Railroads Prevents the Spread of Noxious Weeds. All of the large railroads go through many different areas of agricultural lands. In many areas railroads are accused of spreading noxious weeds, whether or not a particular species was found for the first time on railroad right of way or on adjacent farm land. Noxious weeds, however, do not exist as far as the operation of a railroad is concerned except as they affect the roadbed or track maintenance. Many railroad officials are becoming more and more cognizant of the importance of weed control to agriculture and are willing to co-operate with agricultural authorities in the fight against the spread of weeds.

8. Weed Control Improves the Appearance of the Railroad. The railroad that is free of weeds certainly has a better appearance than one that is overgrown. While appearance in itself is not important as far as the economics of weed control is concerned, a clean weed-free track is a positive reflection of all the factors that have been outlined above.

METHODS OF WEED CONTROL

In the past railroads have used about the same type of practices for controlling weeds as those employed by agriculture. They have actually used cultivation, scalping, mowing and burning. With the development of chemical weedkillers, more and more railroads turned to chemical weed control. However, even at the present time there are a number of railroads that still use mowers and burners. These practices, of course, produce only temporary control. Many roadmasters and other maintenance of way personnel insist that burners actually increase their weed control problems as the vegetation grows faster than ever after a week or two following the use of the burners.

CHEMICAL WEEDKILLERS

The desired chemical for railroad track or roadbed treatment is one that produces a high degree of soil toxicity or sterility. For this reason the chemicals that are classed as soil sterilants are receiving more and more acceptance with railroad maintenance officials. It is of interest to note that most railroad people have been expecting, or at least desire, a weedkiller that needs to be applied only once and their weed problems are ended for all time. This, however, is not necessarily peculiar to railroad personnel for I think it is safe to say that, in the field of agriculture, farmers have been expecting the same thing. It is well known that this is not possible and weed control practices of some kind must be used from year to year with persistence and intelligence to obtain desired results.

Many chemicals are used on railroads. These include the soil sterilants, selective and contact herbicides. Many times they have not been used too intelligently, as for instance certain contact or top

killing herbicides have been used with the expectation of obtaining soil sterility. It should be pointed out, however, that railroads are spending more time and effort in studying the problem and becoming acquainted with the conditions that exist and the methods that are necessary to effect the greatest possible benefits. Some of the chemicals that are being used are:

(1) *Sodium Chlorate*:

This is one of the very first chemicals to be used for railroad weed control. From the beginning the results were usually good except when fires started, which not only burned up the chemical before it could get into the soil to kill weeds, but in some cases actually had disastrous results by causing extensive fires along the right of way. In spite of this disadvantage it was demonstrated many years ago on railroads as well as for agriculture that this chemical was an effective weedkiller for all types of vegetation. For use on railroads it was necessary to eliminate, or at least very substantially reduce, the fire hazard features of sodium chlorate. Sodium chlorate combined with other chemicals has been used for a good many years without any particular difficulty from fires.

(*a*) One of the first proprietary products was the combining of calcium chloride or sodium carbonate with sodium chlorate, which materially lessened the fire hazard but still retained the effectiveness of sodium chlorate as a railroad weedkiller. This product has been used successfully for several years, not only for railroads but for agriculture as well. It has been proved that this compound decreased the fire hazard several fold compared with straight sodium chlorate but it must be pointed out that the product will increase the combustibility of organic matter during hot, dry weather. For railroad roadbed spray applications this chemical is manufactured as a concentrated liquid and then diluted with the desired amount of water during the application process. This liquid compound contains 25% calcium chlorate and 14% sodium chloride. It contains 3 pounds sodium chlorate equivalent per U.S. gallon of the concentrated solution. For railroad use the recommended dosage for the average is 10 gallons of the concentrate per foot-mile of track. This gallonage is at the per acre rate of 248 pounds of sodium chlorate equivalent.

(*b*) Borates combined with sodium chlorate have proved especially effective in decreasing the inflammability of sodium chlorate. For roadbed weed control a compound as a liquid concentrate has been used since 1947 on a number of railroads in the United States. This compound contains 18% sodium chlorate and 9.1% sodium metaborate, anhydrous. On a pound per gallon basis, it contains 2 pounds sodium chlorate and one pound of sodium metaborate, anhydrous. It has proved to be an effective weedkiller when used at the rate of 12½ to 13 gallons per foot-mile. It will be noted that this dosage for chlorate-borate is 25% to 30% greater than the dosage recommended for chlorate-calcium compound. It has been found

through the past several years' use that, to obtain equal weed kill, these two products must be applied on an approximately equivalent sodium chlorate basis.

(*c*) Sodium chlorate-TCA combination: It has been demonstrated in certain areas that TCA is an effective grass killer. The primary disadvantage for railroad use is its low toxicity in the soil after a short period, particularly in the higher rainfall areas, due to the speed of leaching out of the soil. It is also known that it has a rather rapid breakdown in soil and for this reason has not been classed in the group of the so-called permanent soil sterilants. Recent work, principally by Dr. Loomis and his colleagues at Iowa State College, has shown that combinations of sodium chlorate and TCA produce greater toxicity on perennial grasses than either of the two chemicals when used alone at equivalent dosages. They have found that there is a synergistic effect when the two chemicals are applied together. It is interesting to note that in the regions of the United States where Bermuda grass (*Cynodon dactylon*) flourishes that the combination of one part sodium TCA with 2 parts sodium chlorate and applied at 200 pounds per acre has given the most effective results on Bermuda grass and salt grass (*Distichlis spicata*) when compared not only to the degree of plant kills but on a cost basis as well. This rate has not been sufficient to keep the railroad bed free of grass growth for the entire season in the South Eastern part of the United States where Bermuda grass is a particular problem due to the relatively high rainfall coupled with a long growing season. For this reason it has been found that a repeat application in about 6 months was necessary. The application of 25 pounds per foot-mile of the combination about every 6 months has given better results than one application at 50 pounds per foot-mile. In the Northwest States the addition of TCA with chlorate-borate has given increased kills of a number of grass species if applied under favourable conditions as regards rainfall. It has been found that light rainfall soon after application of this combination has given the best results. On the other hand dry weather for a few weeks following the application has shown poor results due, undoubtedly, to the rapid chemical breakdown of TCA under these conditions.

(*d*) Chlorate-borate with 2,4-D and MCP: It is well known that different species of plants vary as to their tolerance or susceptibility to chemicals. This is true of soil sterilizing herbicides such as sodium chlorate, particularly when used at relatively low dosages as on railroads. It is also known that chlorate shows greater toxicity to plants on soils that are acid in reaction than on soils that are highly alkaline. With the relatively light dosage of chlorate that is usually applied on a railroad bed, it is found that chlorate tolerant plants such as fire bush (*Kochia* spp.), California poppy (*Eschscholtzia californica*) and veined dock (*Rumex venosus*) are increasing in population, particularly after most other species have been killed, thereby reducing competition. These three species are highly susceptible to 2,4-D, therefore it

appeared logical that addition of 2,4-D to the weedkiller would be effective. A number of small scale tests proved this to be true and last season one railroad in the United States used this combination entirely. The amount of 2,4-D acid used with this combination was approximately 3 pounds per acre. Indications are that this type of spray is showing greater toxicity to a number of other species, even including grasses. Further tests using MCP with chlorate-borate combination have been made. Moderately large scale use this season has shown rather surprising over-all results. It has been found that MCP is effectively controlling *Kochia*, *Eschscholtzia californica* and *Rumex venosus*. In addition the response of other species to MCP is showing to a greater degree when applied in this combination than when used alone. It is quite evident that in addition to the translocation of this chemical for certain plants there is some root absorption as well. It has been pointed out by a number of researchers that the MCP acid has longer stability in the soil than 2,4-D acid. For this reason we should expect greater root absorption from MCP acid when applied in the above combination.

(2) *Soil Sterilants for Off-Track Work*:

In addition to the roadbed weed control, there are many other areas on railroads where weed control is important. These are in yards and terminals, around buildings, bridges and trestles and the bases of poles on communication lines. It is desirable to keep these areas entirely free of weeds and grass growth for the prevention of fires. Chemicals that are being used for this type of work are chlorate-borate powders, borates and recently CMU, the new organic soil sterilant.

Chlorate-borate powders are combinations of sodium chlorate and sodium pentaborate and have proved to be good weedkillers with relatively long lasting residual effects. They are also safe from the standpoint of decreasing the inflammability of sodium chlorate. It has been found that the rate of application varies with the two products and at about the same ratio as to the percentage of sodium chlorate content. These combinations are on the market as spray powders and vary in sodium chlorate content from 25% to 43%. It has been established by many railroads that where heavy vegetation exists of all types, including shallow rooted annuals and deep rooted perennials, that approximately 3 to 4 pounds of Chlorax Spray Powder are used per 100 square feet and 4 to 6 pounds of Polybor Chlorate are used per 100 square feet. Both of these compounds can be applied dry or they can be dissolved in water and used as a spray. CMU has shown outstanding results for control of vegetation, particularly grasses. The low solubility of this chemical makes it particularly advantageous in areas that are poorly drained or where high soil moisture prevails throughout most of the year. It has been found that this weedkiller is more effective on lighter soils than on heavy compact soils. On heavy soils the chemical does not penetrate to sufficient depths to kill deeper rooted plants and it has been observed

that these species will recover after a relatively short period of time. It is becoming most evident also that in the lighter rainfall sections CMU is not as effective as in areas of heavy rainfall. It has been demonstrated in the past two years that Johnson grass (*Holcus halepensis*), for instance, is not being controlled very effectively with CMU. Johnson grass is adapted to and grows vigorously in the hot and relatively dry sections of the United States. The amount of rainfall in this part of the country is generally not sufficient to move CMU deep enough into the soil. On the other hand, in the Northern section of the country perennial grasses such as *Elymus* and *Agropyron* spp. are being most effectively controlled for long periods of time with CMU. In these same areas, however, species of *Equisetum* and *Juncus*, bindweed and other deep rooted plants are more difficult to bring under control with CMU. The Rushes or *Juncus* spp. are among the most difficult weeds on railroad beds and there are a large number of species that cover a wide range of growing conditions. For instance in the Northwest there are 27 species of *Juncus*, some of which grow in extremely wet or poorly drained conditions ; others grow on deep fills and have tremendous root systems. Substantially greater dosages of chemicals are required to control plants under these unusual conditions.

The borate compounds, principally Borascu, are used extensively on railroads, mostly for the control of all types of vegetation around bridges and trestles to reduce the fire hazzards during the dry season. This weedkiller, if applied during the early part of the growing seasons and if sufficient dosages are used, will adequately control most growth. The low solubility of this chemical is a particular advantage for this type of weed control.

Arsenicals in the form of sodium arsenite used to be one of the very important chemicals for railroad weedkilling. Arsenic is a very good contact herbicide as well as a soil sterilant. At the present time very little is used because of its high toxicity to warm-blooded animals.

Contact herbicides have recently been used on a number of railroads. They are rather spectacular because of the rapid knock-down effect they produce on most of the top growth of plants if used at sufficient volume, but regrowth is quite rapid particularly from perennials. Two or three applications are necessary per season to produce effective controls. Many of these chemicals are relatively low in cost for a single application, but with repeat applications necessary the total cost per mile is not very cheap. These herbicides are weed oils which contain a high percentage (70% to 90%) of aromatic fractions. Dinitrophenol and pentachlorophenol have also been used. These two compounds are sometimes used as fortifying agents in diesel or light fuel oils. A typical spray of this combination is 50 gallons diesel oil, 1 to 2 quarts of dinitro and 50 gallons of water. Relatively high volumes of all these contact herbicides must be used as it is very necessary that the entire plant be thoroughly covered if desired top kills are obtained.

BRUSH CONTROL

The control of woody plants along railroad rights of way is very important and in the past has been a rather difficult and expensive part of a maintenance programme. During the past few years the use of chemicals for this type of work has been increasing. Many railroads have started rather extensive programmes by treating with the hormone brush killers, such as 2,4-D or 2,4,5-T, or a combination of the two. Most of the treatments for brush control on railroads have been of the foliage type of spray and usually applied with on-track equipment to cover the brush for a distance of from 25 to 35 feet on either side of the roadbed. The important area is directly underneath the communication lines to kill out the tall growing species.

It is, of course, well known that there are a number of woody plants that are quite tolerant to either 2,4-D or 2,4,5-T, particularly when foliage applications are made. Basal treatments or stump treatments of these tolerant species effect a higher percentage of kills, but up to the present time very little work of this kind has been done on railroads. In some areas it is becoming evident that if chemical treatments are to be effectively used it will be necessary for more of this type of application to be made.

Of the species that are most tolerant to the hormone type sprays we have found maple and oak to be two of the most difficult. Other species in this group include ash, elm, cedar, dogwood and all species of evergreens. It is also well known that plants or trees that are large in size are more difficult to kill than the smaller growth. For this reason the large species should be cut down and regrowth sprayed from 2 to 4 years after cutting. If trees or brush are allowed to grow and they reach into the communication lines, it is necessary that these be cut down even after they are killed with chemicals as they continue to be a hazard if left standing. In addition to the hormone type weed killers, Ammate is being used successfully as a brush killer. On a number of species this chemical is more effective than 2,4-D or 2,4,5-T. It also has an additional advantage of inducing greater undercover growth, such as grasses, after killing out the brush. Ammate is used at the rate of $\frac{3}{4}$ to 1 pound per gallon of water. Applications are made to cover the foliage thoroughly.

To summarize : Weed control on railroads is one of the most important maintenance problems. All railroads are recognising more and more the value of chemicals for this purpose and many railroads are using chemicals in preference to hand labour. The principles of weed control on railroads, as for agriculture, are directly associated with using the proper chemicals, timing of application and using at least the minimum dosage. All too frequently railroads apply chemicals either at too low dosage, or at the wrong time of the season to obtain proper or desired results.

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RECENT DEVELOPMENTS IN THE CONTROL OF BLISTER BLIGHT OF TEA IN SOUTH INDIA

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THE use of copper fungicides to control Blister Blight of tea in South India and the early successes obtained have already been described in these pages (*Plant Protection Overseas Review, Volume* 2, *No.* 4, *December*, 1951).

At the time of writing the article in question, the UPASI Scientific Department were just embarking upon an extensive programme of field trials to assess the relative efficiency of copper dusts and sprays for the protection of tea from attack by Blister Blight and to investigate the practical problems involved in protecting large acreages of tea in plucking by applications of copper fungicides in dust or spray form. The results of these investigations have already been described elsewhere (*UPASI Sci. Dept. Ann. Adm. Rep.*, 1951-52 *and* 1952-53), but they are worthwhile reproducing at this stage, as a more comprehensive account of the development of prophylactic treatment of tea with copper fungicides can now be given.

THE PROTECTION OF TEA RECOVERING FROM PRUNING

In June 1951 an area of tea at the UPASI Tea Experiment Station was pruned in accordance with normal standards. The area was then divided into two blocks and each block further sub-divided into six plots. The six plots in each block were each assigned one of the following treatments.

(*a*) Control, untreated.
(*b*) Perenox, 2 oz. in 10 gallons of water, at 17 gallons/acre.
(*c*) Perenox, 4 oz. in 10 gallons of water, at 17 gallons/acre.
(*d*) Cuprosana 2% Copper Dust at 10—15-lbs./acre.
(*e*) Cuprosana 6% Copper Dust at 10—15-lbs./acre.
(*f*) Perelan 4% Copper Dust at 10—15-lbs./acre.

The first application of fungicides was made on the 18th July, 1951, three weeks after pruning, and observations commenced on the 8th

August. In 1951 the Blister Blight season at the UPASI Tea Experiment Station could be divided into 3 distinct phases, a period of disease build-up from 8th August until 3rd October, a period of disease decline during mid-October and a period of build-up and heavy re-infection from 31st October to early January 1952, after which the disease died out due to the onset of hot dry weather.

This trial demonstrated conclusively that a good degree of protection to tea recovering from pruning can be obtained by using copper fungicides either in dust or spray form, as is shown from the following figures.

TABLE I.

	Avg. % Bush Infection		Leaf Infection
	8 Aug/ 3 Oct.	31 Oct./ 2 Jan.	13 Nov./18 Dec.
Control	65	58.2	80.6
Perenox 2 oz./10 galls. ...	56.3	41.2	45.5
Perenox 4 oz./10 galls. ...	21.2	16.1	29.7
Cuprosana 2% dust ...	38	25.2	48.8
Cuprosana 6% dust ...	18.5	14.2	33.0
Perelan 4% dust	28.9	29.5	38.6

The information obtained from these figures shows conclusively that very fair protection was obtained from the higher rates of application of sprays and dusts. Two points of interest emerged from the trial. It had originally been believed that 2 oz. of a wettable copper fungicide in 10 gallons of water, if properly applied, would effectively control the disease. During 1951, however, it was quite apparent that, under the prevailing conditions, a dilution rate of 2 oz. in 10 gallons was insufficient for adequate protection. The second point of interest was that, although the plots receiving spray treatments appeared to be freer from disease than the dusted plots, when the bushes were tipped a much greater degree of infection was to be found inside the bushes on the sprayed plots than on the dusted ones, indicating that the penetration of dust into the centre of the bush was likely to be more efficient than that of a fine top spray.

This investigation was extended in 1952, when a trial was carried out to compare the efficiency of spraying and dusting as practised under normal estate conditions. Through the kind co-operation of a neighbouring estate a block of about 5 acres of tea was placed at the disposal of the UPASI Scientific Department and each month from June 1952, up to and including October, an area of $\frac{3}{4}$ acre of tea was pruned in the first few days of each month. These areas were sub-divided into 3 plots, which were either left untreated, sprayed or dusted; in each case the plots were surrounded by a double row of unpruned guard bushes, which themselves served as centres of disease infection. Applications of fungicide to the sprayed or dusted plots were commenced approximately 14 days after the conclusion

of each pruning operation and continued throughout the Blister Blight season, up till the end of January 1953. A 50% wettable copper fungicide applied at the strength of 4 oz. in 10 gallons of water and at the rate of 16 gallons per acre was used for wet spraying, application being by pressure-retaining knapsack spraying equipment fitted with low-volume spray jets, while dusting was done initially with Cuprosana 6% Copper dust until tipping time and with Cuprosana 4% Copper dust thereafter, using standard pattern rotary type hand-dusters. The rate of application of dust in both cases varied between 5 and 8-lbs. per acre and spraying or dusting rounds were carried out at 4 or 5 day intervals between commencement of treatment and tipping, thereafter the intervals between applications being extended to 8 to 10 days.

Examination of the figures of intensity of bush and shoot infection throughout the period, obtained by leaf counts from a block of bushes in the centre of each plot, showed that both spraying and dusting gave adequate protection, with little or nothing to choose between them. Continuous observation of the experiment however did suggest that the protection given by wet spraying was in this case superior to that given by dusting, though the difference may not in fact be of economic significance.

TABLE II.

		Average % Intensity of Infection			Average % Shoot Infection		
		Control	Sprayed	Dusted	Control	Sprayed	Dusted
June	Pruned	20.0	6.5	6.9	38.7	15.25	15.4
July	,, ...	13.8	4.6	8.9	30.0	11.0	20.1
August	,, ...	20.1	4.7	4.4	46.5	11.3	10.7
September	,, ...	6.6	1.9	1.8	10.1	4.2	4.5
October	,, ...	1.4	0.9	1.1	3.0	2.25	3.5

Throughout the period of the trial yield records were maintained for the individual areas. When these figures are corrected to account for variation in bush numbers, yields of the various treatments are :—

Control	521	lbs. green leaf
Sprayed	1,079	,, ,, ,,
Dusted	1,070	,, ,, ,,

It would not be right to place too much significance on these figures, even though differences are so great, but they do illustrate the striking benefit to be derived from protecting tea recovering from pruning with some form of fungicide, and a further examination of the figures for the individual months of pruning suggests most strongly to the investigator that the initial benefit derived from bush protection during the early stages of recovery from pruning is maintained to a marked degree throughout the following period.

The investigations of the last two years have demonstrated conclusively that, under conditions of disease attack common in South

Fig. 1.—Pruned Tea—Untreated (Compare with Fig. 2.)

Fig. 2.—Pruned Tea—Dusted (Compare with Fig. 1.)

India, the protection of tea recovering from pruning during periods of intense Blister Blight attack is entirely possible using either hand-operated spraying or dusting equipment and the choice of whether to dust or spray is one to be made on the basis of costs and practical considerations rather than on efficiency of control.

POWER DUSTING OF TEA

During the same period the UPASI Scientific Department carried out an investigation of power dusting of tea in plucking to study the problems involved in the large-scale application of copper fungicides in dust form under difficult conditions. With the co-operation of an estate in the Anamallais, two fields totalling 69 acres were selected for the experiment; the area chosen was, in fact, one of the most difficult areas in South India from the point of view of climate and topography, being situated high on the slopes of an exposed valley which acts as a funnel for the South-West Monsoon. The area in question is subject to violent winds, thick mists and, at times, intense rain and throughout the Blister Blight season conditions for dusting are usually bad. The area was deliberately selected as providing the worst possible conditions, which would thereby stress the practical problems involved in such operations. Throughout the trial a specially formulated Perelan 4% copper dust supplied by Imperial Chemical Industries (India) Ltd. was used, the dust being applied by a "Whirlwind" Power Duster reinforced by two "Armada" Rotary Hand Dusters. Under the conditions of the trial and working with untrained labour it proved difficult to dust more than about 15 acres of tea per hour and at this rate of application power dusting appeared to be a very expensive proposition, as the saving in labour compared with wet spraying was very slight. A number of lessons were learnt from this trial, however, the chief among them being that a high degree of organisation and supervision are required if power dusting is to be a practical and economic proposition.

At the same time as this trial was in progress, two estates near the UPASI Tea Experiment Station were carrying out their own trials with power dusting equipment, and by their kindness the UPASI Scientific Department was able to watch the progress of these investigations and to study the effects of disease control and the economics thereof.

In one case 356 acres of tea, which included 276 acres of first year fields, were treated with 2% Cuprosana dust, at an average rate of 10 lbs. per acre per round, using a "Whirlwind" Power Duster. Throughout the season a total of 6,372 acres were dusted and 62,502 lbs. of Cuprosana 2% dust were applied, the average running cost working out at Rs.5.3 per acre per round, exclusive of staff supervision and capital depreciation of the Power Duster. This figure includes the cost of import duty of the fungicide, which was subsequently recovered from the Government of India, thereby showing a reduction of 25% on the cost of material, the final cost working out at about Rs.4/8-per acre per round of dusting.

This trial provided an admirable opportunity of assessing the protective efficiency of the power dusting treatment. Three fields closely comparable regarding past history, type of tea, growth rate, topography, and liability to disease attack were studied and the figures of yields maintained. From the beginning of the financial year in April 1951, until the end of July, yields of the respective fields in terms of pounds of green leaf per acre were :—

Field No. 16	—	1,505 lbs per acre
11	—	1,633 „ „ „
20	—	1,690 „ „ „

In the following 6 months, during which Blister Blight was active and dusting was in operation, the yields of green leaf per acre on these fields were :—

Field No. 16	—	1,997 lbs. per acre
11	—	2,577 „ „ „
20	—	2,546 „ „ „

From these figures it is apparent that during the period of Blister Blight attack, the two dusted fields, Nos. 11 and 20, gained considerably in crop over the undusted field, an observation which was further emphasised when the yield records of individual plucking rounds from August 1951 to March 1952 were plotted and scrutinised.

For various reasons similar figures were not available from the other estate where a similar trial was in progress, but, from the records of that trial which were available for scrutiny, the efficiency of the treatment with Cuprosana 2% dust at the rate of 10 lbs. per acre on an 11 to 12 day round stands out. From the period of 31st October until the 15th December the average infection count from a dusted field, based on the study of flush harvested from a selected area, gave a flush infection index of 212, while from a comparable undusted field the flush infection index was 900. During the critical period 15th November to 15th December, the index of the dusted field was 230, while for the undusted field it was as high as 1,550.

From the information gained in these and other trials during the course of 1951, it now appears that prophylactic dusting with a copper dust is a practical and economic proposition if carried out with a high degree of organisation and supervision, and during 1951 it seemed that 2% Cuprosana dust applied at the rate of 10 lbs. per acre at 7 to 10 day intervals gave adequate protection to tea in plucking and beneficial effects were to be noted not only in the increased crop, but in the more vigorous appearance of the tea at the end of the Blister Blight season.

In this connection, however, the following extract from the UPASI Scientific Department Annual Administration Report of 1951-52 is worthy of reproduction :—

"There is reason to believe, however, that in cases of severe disease attack and in certain areas where the topography renders the tea susceptible to prolonged attacks of the disease, a 2% copper

dust is inadequate and a 4% copper dust will be required to give adequate protection. Whether in this case the rate of application may be materially reduced is a matter for speculation and further investigation, but it is our opinion that efficient coverage cannot at present be obtained with power equipment at rates less than 7 lbs. of dust per acre."

It is now generally accepted that a 4% copper dust is necessary for adequate control.

By 1952 the majority of estates in South India which were liable to severe Blister Blight attack had already arranged to carry out some form of prophylactic treatment. Newer and more efficient patterns of knapsack spraying equipment and low volume nozzles and a better understanding of the problems involved, particularly with regard to organisation and supervision, led to an increase in the acreage of tea protected by wet spraying and few estates were not committed to some programme of spraying or dusting.

POWER SPRAYING OF TEA

During 1952 the UPASI Scientific Department investigated the possibility of the power spraying of tea with a prototype " Micron Sprayer " using an oil-water emulsion of a standard 50% wettable copper fungicide. Preliminary investigations showed that the average swathe width of the machine was approximately 80 ft. and on this basis it was found possible to treat 30 acres of tea bordering a motor road with 45 gallons of spray liquid in 50 minutes. 6 oz. of a 50% wettable copper fungicide were applied to each acre of tea in the form of an oil-water emulsion made by adding 2% by weight of a proprietary emulsifiable white oil to the spray solution.

Field observations indicated that protection was adequate only up to a distance of 60 ft. from the machine and on this basis it was felt that, unless a coverage of approximately 3 times this extent could be obtained, there would be little practical value in machines of this type and under such conditions power dusting would seem to be preferable.

These trials concluded the main programme of investigations into field scale control of Blister Blight of tea in South India with copper fungicides and as a result a procedure for the effective control of the disease has now been established.

It remains to be seen whether the economic situation will permit the continuance of a heavy expenditure on crop protection throughout the whole of the Blister Blight season and logically the next investigation should be concerned with developing a warning system based on an accurate method of forecasting conditions favourable for disease development, a practice already reported from Indonesia, coupled with the possibility of employing a technique of extensive prophylactic spraying or dusting on receipt of such warning, in which case a heavy build-up of disease infection likely to cause crop loss might be avoided without the necessity of recourse to expensive and protracted crop protection programmes.

TECHNICAL BREVITIES

This section includes information on plant protection problems obtained from published literature. We give references to the publications concerned.

INSECTICIDES

SEED TREATMENT WITH GAMMA-BHC FOR THE DESTRUCTION OF WIREWORM AND SEED-CORN MAGGOT.

IN *California Agriculture*, Vol. 7, No. 5, pages 7—8, 1953, W. H. Savage and others give recommendations for the destruction of wireworms and seed-corn maggots (*Hylemia* (*Delia*) *cilicrura*) by seed treatment with lindane preferably by applying the insecticide with a fungicide and sticking the mixture on the seed by using the liquid fixation, spray, or slurry methods. The paper includes a table of dosage rates for lindane applied in different ways to 30 field and vegetable crops. Treatment against wireworm is more effective with larger seeds (*e.g.*, beans, maize, wheat) that normally attract this pest than with smaller seeds (*e.g.*, lettuce, carrot, lucerne, grass). Better results are also obtained with seeds in which the old seed balls or seed coats remain in the soil, for wireworms contacting these are often affected for several weeks after sowing. Lindane can be safely combined with thiram, chloranil, captan, organic mercury and other fungicides.

MAIZE-STALK BORER

F. Taylor reports in *Farming*, S. Africa, Vol. 27, No. 319, 1952, that maize is effectively protected against stalk-borer (*Busseola fusca*) in the Orange Free State by introducing a small quantity of a 2½% DDT dust into the open funnel of the young maize plant while the larvae are feeding there and before they have bored into the stem. Application is made by means of a container having a perforated lid. About 10 lb. of dust is required per morgen (2.116 ac) (21.2 lb. per acre) when every plant is dosed. A man can treat 2 morgen (4¼ ac.) per day.

COTTON JASSID TREATMENT: ECONOMICS OF DDT SPRAYING.

O. W. Snow and J. Taylor, in the *Bulletin of Entomological Research*, Vol. 43, No. 3, 1952, pages 479—502, discuss the results of large-scale

treatment of the cotton jassid, *Empoasca lybica*, over four seasons in the Gezira and White Nile cotton areas, using mainly 0.1% DDT at 100 gal. per feddan (*i.e.*, about 1 lb. DDT per ac.). Early (October) spraying was more profitable than later (November) spraying. Yield increases attributable to spraying were rather greater on manured land. The average yield of cotton in the Gezira without spraying is about 4 kantars per feddan or acre (roughly 1,200 lb. of unginned cotton or 400 lb. lint plus 800 lb. seed) and increases from spraying of 25% were quite common. Sometimes 1 lb. or even ½ lb. DDT led to increases of over 50% in yield. A loss of efficiency in spraying of only 1%, for example, owing to less suitable formulation or poorer application, can involve a loss of up to 25 lb. lint plus 5 lb. seed per feddan and even an extra 1 lb. lint per feddan over a large area is worth a considerable sum of money. In 1949/50 in the Gezira, spraying of 137,000 feddans at a cost of £200,000 brought in an increase of 220,000 kantars worth between £4,000,000 and £5,000,000.

CAMPAIGN AGAINST RICE BUG.

In the *F.A.O. Plant Protection Bulletin*, Vol. 1, No. 6, 1953, H. S. Pruthi states that in India the rice bug (*Leptocorisa varicornis*) was responsible for an average crop loss of 10% in 1952, over 7½ million acres being infested. This loss was mostly in early maturing varieties. Had not the Central and States Government organised a large-scale programme of treatment using BHC and DDT much additional damage would have been done to medium and late crops. To meet future threats, a central pool of equipment is being established for despatch to endangered regions when necessary.

TREATMENT OF GRAPES AGAINST MEALYBUG.

A paper by A. C. Myburgh and P. J. Kriegler in *Farming in South Africa*, Vol. 28, No. 323, 1953, discusses the treatment of table grapes in South Africa against the very destructive mealybugs, *Pseudococcus maritimus* and *P. citri*. Parathion is recommended as two summer sprays with a 14-day interval between, at 18.4 oz. of 20% material per 100 gallons or its equivalent. In old vineyards, it is necessary to spray stems, laterals, bases of green shoots and bunches. In young vineyards, late applications need not include the stem treatment. In no case need all the foliage on trellised vines be sprayed.

STRAWBERRY MITE.

W. E. van den Brual and G. Collin, writing in *Parasitica*, Vol. 9, No. 1, 1953, state that in Belgium gamma-BHC 0.03% is effective in suppressing strawberry mite (*Tarsonemus pallidus*) when sprayed direct into the crown of the plant shortly after planting, three applications at weekly intervals being sufficient. For field use, a rate of 2,000 litres per hectare is suggested. Treatment with parathion is not good unless more frequent applications are made (three times per week) and then at rates above 300 grammes per hectare.

TREATMENT OF CAULIFLOWER AGAINST CABBAGE ROOT FLY.

D. W. Wright in the *Report of the National Vegetable Research Station* for 1951, published in 1952, states that gamma-BHC and chlordane applications on cauliflower are very efficient remedies against cabbage root fly (*Erioischia brassicae*) on cauliflower in the United Kingdom. BHC 0.17% and 0.45% dusts give up to 94% protection when applied around the stems of transplanted plants at 45 lb. and 17 lb. per 4,840 plants respectively, but only 41.7% protection is given when the dusts are broadcast and raked in, even at rates of 444 lb. per acre. Chlordane 5% dust (30 lb. per 4,840 plants) gives even better protection (98.5%). Toxaphene 5% dust is inferior. Using aqueous suspensions, gamma-BHC 0.01% to 0.1%, chlordane 0.1%, and parathion emulsion 0.1% all give excellent protection.

DDT PICK-UP BY PEA APHIDS.

G. A. Wheatley, in the *Report of the National Vegetable Research Station* for 1951, states that DDT picked up from the dusted surface of the plant is the main source of the toxicant in the destruction of pea aphid (*Acyrthosiphon pisum*) rather than the dust deposited directly on the insect's body. Dusting is best done at temperatures above 65° F., so that full use is made of the activity of the aphid.

EFFECT OF INSECTICIDES ON PERFUME FROM FLOWERS.

R. Pussard states in *Comptes Rendus de l'Academie Agric. Fr.*, Vol. 39, No. 3, 1953, that when roses grown for perfume-making in France were sprayed at flowering time with insecticides at dosages toxic to insects, and the flowers were collected on the same or on the next day the quality of the essence extracted from them was impaired by certain of the materials. The carriers of dusts, talc in particular, had no abnormal effect on the essences. But certain insecticidal dusts, notably those based on technical BHC (8%) and its sulphur derivative, S.P.C. (10%), imparted a tenacious odour to essences quite incompatible with their utilization in perfumery. All synthetic products used, even those having little odour, seemed to affect quality of the rose essences. Pending further studies, it is suggested that all treatment of perfumery plants should be proscribed at harvest time and during the eight preceding days at least. At present, laws in France concerning plants in flower relate only to those visited by bees, and ignore roses and jasmin which are not.

CHRYSANTHEMUM LEAF EELWORM

In the *Plant Disease Reporter*, Suppl. 210, 1952, pages 17-18, it is reported that leaf nematodes (*Aphelenchoides* sp.) attacking chrysanthemum in New York are efficiently suppressed by parathion, using either 15% Wettable Powder as a foliage spray at 1 lb. per 100 gallons or 0.2 gr. active parathion per 1,000 sq. ft. as a soil drench. Application

of diethyl ethyl-mercaptoethyl thiophosphate ('Systox') is another good treatment (½ lb. per 1,000 sq. ft.). Schradan at the same strength is effective as a spray.

CHRYSANTHEMUM EELWORM

According to the *Report of the Edinburgh College of Agriculture* for 1951-52, published in 1952, chrysanthemums were very effectively protected against eelworm (*Aphelenchoides ritzema-bosi*) by monthly applications of 20% parathion at 1 oz. per 2½ gallons starting three weeks after cuttings were taken. Parathion at half this strength was also effective.

THE USE OF METHYL BROMIDE AGAINST ATTA ANT.

A. B. Kennerly reports in *Down to Earth*, Vol. 9, No. 1, 1953, that effective treatment in Texas against the Texas leaf cutting ant, *Atta texana*, which is a serious pest of field crops, fruit trees and pine seedlings on sandy soil, consists of introducing methyl bromide near the centre of the colony by a rubber tube attached to the applicator. The chemical is packed as a liquid in 1 lb. cans and changes to a gas when the can is punctured. One can is enough to destroy a colony. Treatment is best done in winter or early spring when the ants are concentrated in the centre of the colony.

FALL WEBWORM

In *Plant Protection* (Belgrade) numbers 16—17, 1953, H. Ehrenhardt reports the results of laboratory and field trials against the larvae of the fall webworm (*Hyphantria cunea*). The trials show that larvae up to the third stage are destroyed by DDT, BHC, BHC-DDT, parathion, dieldrin, and Holfidal (carbazol) as sprays or dusts. Gamma-BHC and dieldrin are less effective than the other materials against older larvae and require higher concentrations than is usual in practice to give satisfactory kills. It is suggested that chemical treatment should be carried out before the third larval stage. If attack is slight, mechanical treatment is recommended.

DESTRUCTION OF CAPNODIS BEETLE.

In *C. R. Acad. Agric. Fr.*, Vol. 38, No. 17, 1952, M. Feron reports that BHC is shown to have good persistence against the capnodis beetle (*Capnodis tenebrionis*) attacking apricot trees in France. A single application to the soil by watering or dusting remained effective for a year whether made to growing trees before oviposition or before planting in winter. It is now recommended that trees treated for the first time should receive one application before oviposition (about mid-May) and one after harvesting the apricots (July). Thereafter treatment need be made only every second year. Dosages are 3 to 5 litres per tree of a suspension containing 0.24% gamma isomer of BHC or of a 1% technical BHC dust at 50 to 100 g. per m^2. The

materials should be applied to the collars and the soil for about 50 to 60 cm. around trees. There has been no phytotoxicity nor taint to apricots.

ARGENTINE ANT ATTACKING TRELLISED VINES.

H. J. R. Dürr, in *Farming in South Africa*, Vol. 28, No. 323, 1953, reports that effective and practicable suppression of the Argentine ant (*Iridomyrmex humilis*) attacking trellised vines in South Africa was obtained by the use of insecticides as barriers. Vines, struts, and diagonal wires were treated from ground surface to knee-height. Best results were given by 1% DDT emulsion or wettable powder which remained effective for 7 to 8 weeks and kept populations low for 12 to 14½ weeks. Gamma-BHC treatment at 0.25% was effective for only 2 weeks. Dieldrin at 0.25% and chlordane at 2% were effective for 1 week. Toxaphene and parathion were poor.

FUNGICIDES

SEED DISINFECTION AGAINST MILLET SMUT.

W. A. R. Dillon Weston and Elizabeth R. Schofield, in *Plant Pathology*, Vol. 1, 1952, pages 29—30, report the results of seed treatment trials at Cambridge in 1950.

Clean millet seed, after being kept in a saturated atmosphere at 28° C. for 5½ hours, was shaken in a closed jar with smut spores (*Sphacelotheca destruens*) taken from an infected millet head from a crop grown in Essex.

Different lots of the contaminated seed were treated respectively as follows :—

(1) Shaken (dry) with organo-mercury seed dressings, A, B and C, each at 3 oz. per bushel.

(2) Shaken (dry) with copper carbonate at 2 oz. per bushel.

(3) Shaken with a preparation containing 50 per cent thiram at 6 oz. per bushel.

Wet treatments were also carried out with

(1) Copper sulphate (five minutes' steep in 2½ per cent solution), and then air dried and sown within 24 hours.

(2) Formaldehyde (by sprinkling the seed with a solution of 1 part of 40 per cent formaldehyde in 320 parts of water) and then sown within 48 hours.

The results obtained were as follows :—

All the organo-mercury treatments and copper carbonate were completely successful, apart from a single smutted head in one plot.

Copper sulphate treatment resulted in only two smutted heads in 1,763.

Formaldehyde and thiram treatments were followed by the production of 1 per cent and 0.5 per cent infected heads, respectively.

Untreated seed gave 25 per cent smutted heads.

Organo-mercury treatment 'A' and thiram resulted in an increase in the total number of heads in each case.

A further trial in 1951 resulted in the production of 73 per cent smutted heads from untreated seed, 17.5 per cent smutted heads from formaldehyde treated seed, and no infection from treatments A & B, organo-mercury seed dressings.

TEN YEARS EXPERIMENTS IN THE FIGHT AGAINST APPLE MILDEW [(*Podosphaera leucotricha*) (E. & E.) Salm.].

A report on experiments in the fight against apple mildew (*Podosphaera leucotricha*) presented by L. Zobrist and H. Frohlich in *Phytopath Z.*, Vol. 19, No. 4, 1952, contains the following information.

Primary infections are inevitable through the failure of dormant sprays to destroy the mycelium overwintering in the buds.

The addition of a spreader to the spray mixture and thorough 'washing' with twice the usual quantity of mixture are necessary to deal with the thick mat of conidiophores.

The best results in an experimental programme in 1951 at the Biological Laboratory of Dr. G. Maag A. G., Dielsdorf-Zurich, were obtained with seven applications (between 11th April and 10th August, inclusive) of micronized wettable sulphur plus a spreader.

Incidence of secondary infection (at one final count on 25th September) was reduced from 97% to 5% where no treatment had been carried out for the five previous years. Where trees were left untreated in 1951 only, the incidence of infection was reduced from 68% to 5%.

The concentration of the fungicide used was 0.75% for the first three sprays and 0.5% thereafter, and that of the spreader was 0.2% until the last treatment, when it was 0.1%.

Great importance is attached to the rapid succession of the pre-blossom and petal fall applications, and to repetitive treatments over a period of years. The same schedule is effective against apple scab (*Venturia inaequalis*).

RIPE SPOT OF APPLE.

According to G. C. Wade, in the *Tasmanian Journal of Agriculture*, Vol. 24, No. 1, 1953, ripe spot or target spot, caused by a species of *Gloeosporium* (*Neofabraea*) is one of the most serious diseases of apples in Tasmania and is effectively treated by thiram and by captan sprayed at the calyx stage. Ferbam was rather less effective and other materials were inferior.

TREATMENT AGAINST COFFEE BERRY DISEASE: NEED FOR A SYSTEMIC FUNGICIDE.

Investigations on all aspects of coffee berry disease in Kenya since the first record of this trouble in 1922 are extensively reviewed by R. W. Rayner in the *East African Agricultural Journal*, Vol 17, No. 3, 1952. There is now little doubt that a strain of *Colletotrichum coffeanum* Noack is the fundamental cause of the disease, but the perfect stage of this fungus, known as *Glomerella cingulata* (Stonem) Spauld et V. Schr., has never been observed on coffee plants. The disease, which attacks the green berries and destroys the beans, is the most serious fungus disease of coffee in Kenya and has caused the abandonment of coffee-growing in many promising areas. It normally attacks coffee at altitudes over 5,000 ft. and is associated with cold humid conditions. The fungus can exist in a "latent" condition on the bushes and it is apparently only under certain physiological conditions of the host fruit that an actively parasitic form of the fungus arises. Soil factors including mineral nutrition have been thoroughly studied and found to have no effect on the disease. Attack is not correlated with chemical composition of the plants. Numerous spraying trials have shown that most fungicides can give some protection against the disease, especially with frequent application, yet none has been efficient enough to be economic. The sprays used include various formulations of Bordeaux and Burgundy mixtures, lime-sulphur, Bouisol, oil emulsions, Shirlan A.G., and various copper compounds. At present, 'Perenox,' phenyl mercury Fixtan and 'Tulisan' are under trial. It is believed, however, that unless a completely new type of fungicide is produced, economic protection by spraying is unlikely to be obtained. Only an efficient systemic, if such existed, seems to hold out much hope of a reliable and economic remedy.

NARCISSUS BASAL ROT TREATMENT: PHENYL MERCURIC ACETATE DIPS.

In the *Plant Disease Reporter*, Suppl. 210, No. 18, 1952, it is stated that an effective treatment against basal rot (*Fusarium* sp.) of narcissus consists of dipping the bulbs for five minutes, three days after digging and again before planting, in phenyl mercuric acetate at 10 lb. per 800 gallons or 2% phenyl mercuric acetate in bentonite (Mersolite) 1 lb. per 800 gallons.

SEED TREATMENT OF ONION AGAINST SMUT.

In the *Annals of Applied Biology*, Vol 40, No. 1, 1953, H. E. Croxall and C. J. Hickman state that onions are effectively protected against smut (*Urocystis cepulae*) in the United Kingdom by treating the seed with ferbam or thiram 50% applied with a resin-potash sticker. Chloranil and calomel are ineffective and organic mercurials cause serious seed injury.

PREVENTION OF SEED-BORNE DISEASE BY MICROBIAL ANTAGONISM.

M. Treit states in *Nature* (London), Vol. 172, No. 4366, 1953, that oat seedling blight (*Fusarium nivale*) is effectively prevented by the action of *Chaetomium cochliodes* in the soil under natural conditions. The degree of protection is as good as that by organo-mercurial seed dressing. Wide differences in degree occur between various strains of the organism. The mechanism of its action awaits further investigation; there is some evidence that it is by diffusion into the infested seed of one or more antibiotic substances produced by the fungus.

WEEDKILLERS

CHEMICAL TREATMENT OF SKELETON WEED (*Chondrilla juncea*).

Kelvin R. Green reports in the *Agricultural Gazette of New South Wales*, Vol. 64, No. 5, 1953, that the success achieved from spraying skeleton weed in young cereal crops in N.S.W. resulted in a rapid increase in this form of treatment in 1952. Treatment of fallow or ley has, however, given only a temporary set-back to the weed.

The recommended rates of application for 1953 are $\frac{3}{4}$—1 lb. 2,4-D as the amine salt per acre, though $\frac{1}{2}$ lb. per acre will cause some suppression of skeleton weed with less risk of damage to clovers and medics, but 1 lb. per acre for maximum effect where fertility is low.

2,4,5-T is less toxic than 2,4-D to skeleton weed and more damaging to clovers. MCPA is disappointing, and 2,4-D esters are not as satisfactory as the 2,4-D amines. 2,4-D sodium salt has the disadvantage of being a powder, which is difficult to dissolve and not easily measured in the field. 2,4-D should be applied after the crop is fully stooled and before the head can be distinctly felt in the stem.

As a result of some treatments there has been a considerable reduction in skeleton weed during the following season.

Crops under-sown with medics (trefoils) should not be sprayed with 2,4-D.

Spraying should be regarded as an adjunct to sound farming methods and not as a substitute for them. When applying 2,4-D care should be taken to prevent damage to susceptible crops in the vicinity.

USE AND EFFECT OF SELECTIVE WEEDKILLERS ON FLAX.

L. Detroux states in the *Rev. Agric. Brux.*, Vol. 5, No. 10, 1953, abstracted in *Field Crop Abstracts*, Vol. 6 No. 3, 1953, that in trials on the application in spray form of varying concentrations of MCPA, DNOC and DNBP to flax from the cotyledon stage to time of maturity observations were made on the state of the plants during growth. Assessment of fibre quality was also made.

The trials showed that :—

MCPA at strengths of up to 400 g. in a water solution of 1,000 litres per ha.,

the sodium salt of DNOC at strengths of up to 1,800 g. in a water solution of 700 litres per ha.,

and DNBP at strengths of up to 540 g. in a water solution of 800 litres per ha. can be used without damage either to the plant or its fibre.

LACK OF TOXICITY OF 2,4-D AND MCPA FOR FISH IN RICE FIELDS.

According to Enrico Marini in *Notiz. malattie piante* (Italy), No. 19, pages 17—18, 1952, abstracted in *Chem. Absts.*, Vol. 47, No. 11, 1953, the mean lethal dosage for carp was found to be 65 parts per million in the case of each herbicide. This concentration was never reached by the usual sprays.

USE OF 2,4-D FOR RAISING THE YIELD OF SEEDS OF ALFALFA AND ESPARSETTE.

V. V. Koperzhinskii reports in *Doklady Akad. Nauk S.S.S.R.*, Vol. 88, pages 353—6, 1953, abstracted in *Chem. Absts.*, Vol. 47, No. 13, 1953, that the best improvement of alfalfa seed was obtained by spraying the plants with 0.0005% solution of 2,4-D acid, lower and higher concentrations giving poorer results. Plants giving a high seed yield produced a low yield of plant residue (straw).

Application of sodium salt or 2,4-D gave similar results, but alfalfa suffering from drought does not respond.

Drop of esparsette seed pods is reduced by the use of 0.0005% solutions of 2,4-D some 10 to 15 days before harvest, the crop yield being improved as a result.

CHEMICAL TREATMENT OF *PANICUM* spp.

Enrico Marini reports in *Notiz. malattie piante* (Italy), No. 19, pages 21—23, 1952, abstracted in *Chem. Absts.*, Vol. 47, No. 11, 1953, that the application of sodium chlorate (200 g. in 1.5 1. water per 10—15 sq. m.) and chlorobenzenes (50—100 cc. per sq. m.) proved to be the best treatment against *Panicum* spp.

SENSITIVITY OF ARTEMISIA VULGARIS TO PHYTO-HORMONIC WEEDING.

According to Enrico Marini in *Notiz. malattie piante* (Italy), No. 19, pages 14—16, 1952, abstracted in *Chem. Absts.*, Vol. 47, No. 11, 1953, spraying with 4 kg. MCPA (as sodium salt) per hectare resulted in complete suppression of the weed.

SENSITIVITY OF RICE WEEDS TO 2,4-D AND MCPA AS RELATED WITH SOME CULTURAL METHODS.

In an article published in *Notiz. malattie piante* (Italy), No. 19, pages 18—21, 1952, abstracted in *Chem. Absts.*, Vol. 47, No. 11, 1953, Enrico Marini reports that suppression of *Alisma plantago*, *Scirpus mucronatus* and *Cyperus difformis* in rice fields by applications of 2,4-D (Sodium salt or butyl ester) or MCPA was helped by raising the water level after treatment with the herbicides, the reverse being true for *S. maritimus*. Resistance to the herbicides by *S. mucronatus* was induced by the application of nitrogen fertilizers. Drying the field before treatment had no effect on the results.

HORMONE DERIVATIVES IN UNDERSOWN CROPS AND IN GRASS SEED PRODUCTION FIELDS.

Ewer Äberg and Erik Hagsand report in *Växtodling*, No. 7, pages 62—70, 1952, abstracted in *Chem. Absts.*, Vol. 47, No. 12, 1953, that no damage to undersown crops (clover), after the clover was at least 4 cm. tall, resulted from the application of 5 litres ' Agroxone ' or ' Sevtox ' per ha. to an accompanying crop of oats or spring wheat, 20—25 cm. tall. No damage to the accompanying crop resulted from the application of as much as 20 litres per ha.

For the effective treatment of fields for grass seed production with salts of 2,4-D the grass should preferably be 15—25 cms. tall.

In grass fields ' Methoxone ' was used against weeds easy to kill and 2,4-D amines against undesired clover.

Spraying with a mixture of 2,4-D and 2,4,5-T suppressed *Gallium mollugo* in fields of timothy.

APPENDIX

The following chemicals mentioned in this issue are available in the 'Plant Protection' range of products under the associated trade names :—

Lindane

'Gammalin' Liquid Concentrate, containing 10% gamma BHC.

Lindane—Combined with Organo-Mercurial Compounds.

'Mergamma' A, containing 1% mercury and a substantial proportion of gamma BHC.

'Mergamma' B, containing 1% mercury and a higher concentration of gamma BHC than does 'Mergamma' A.

'Mergamma' C, containing 2% mercury and a higher concentration of gamma BHC than does 'Mergamma' A.

Benzene Hexachloride (BHC).

'Agrocide' insecticides, containing 2.6%, 6.5%, 10% and 13% gamma BHC respectively.

DDT

'Didimac' insecticides, containing 25% and 50% DDT respectively.

Parathion

'Fosferno' insecticides, containing 20% and 50% parathion respectively.

Thiram

'Fernasan' A, seed dressing.

Organo/Mercurial Compounds

'Agrosan' GN and GN5—seed dressings, containing organo-mercurial salts equivalent to 1% and 5% mercury respectively.

Sodium Chlorate

'Atlacide.'

2,4-D

'Fernoxone,' containing 80% sodium salt of 2,4-D.

'Fernimine,' containing 2,4-D as an amine salt.

MCPA

'Agroxone' 4, based on the potassium salt of MCPA, and containing approximately 4-lb. acid equivalent per Imperial gallon.

Sodium Arsenite

'Weedicide' Concentrate.

2,4,5-T

'Trioxone.'

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